WATER RESOURCES REPORT 3

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BY

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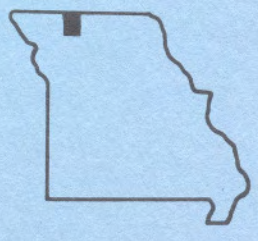

MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES

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Dale L. Fuller, J. R. McMillen, and W. B. Russell

1956

STATE OF MISSOURI
Department of Business and Administration
Division of
GEOLOGICAL SURVEY AND WATER RESOURCES
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# WATER POSSIBILITIES FROM THE GLACIAL DRIFT OF HARRISON COUNTY

A special study of groundwater by the Missouri Geological Survey and Water Resources was made possible at the 1955 session of the Missouri Legislature. With the approval of the Governor, money was appropriated from the Missouri Post War Surplus Reserve Fund.

Since nearly two-thirds of the counties located north of the Missouri River are deficient in water supplies, much of the effort of this special study is being directed toward the problems of this area.

It has been shown that a program of test drilling can locate new reserves of groundwater. Potential areas are being tested so that additional supplies will be available for domestic, irrigation, industrial and municipal needs.

The most favorable areas are in the sand and gravel filled channels and valleys of pre-glacial and inter-glacial streams. Since these buried valleys do not conform to present day drainage patterns, a systematic program of test drilling is a principal means of locating the channels and mapping their extent. Such glacial deposits have proved to be excellent sources of groundwater.

## QUALITY OF WATER FROM ROCK WELLS

The water from the consolidated rock formations which underlie Harrison County is, for the most part, mineralized. The following are analyses from water wells and oil tests:

| CONSTITUENTS | IN PARTS PER MILLION | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Turbidity | slight | slight | 15 | 25.0 | turbid |
| Odor | musty | none | none | | slight $H_2S$ |
| pH | | | 7.4 | 7.6 | |
| Alkalinity ($CaCO_3$) | 327.0 | 550.2 | 250.5 | 401.0 | 443.7 |
| Phenolpthalein | | | 0.0 | | |
| Methyl Orange | | | 250.5 | | |
| Carbonate ($CO_3$) | 00 | 00 | 0.0 | | 15.4 |
| Bicarbonate ($HCO_3$) | 398.8 | 671.0 | 305.6 | 489.2 | 541.1 |
| Silica ($SiO_2$) | 23.6 | 7.2 | 12.0 | 8.0 | 4.4 |
| Oxides($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 4.24* | 5.93* | 1.0 | | 0.00* |
| Calcium (Ca) | 105.5 | 48.8 | 200.4 | 94.5 | 31.6 |
| Magnesium (Mg) | 36.4 | 20.2 | 65.9 | 32.5 | 16.9 |
| Sodium(Na)and Potassium(k)as Na | 78.1 | 1675.9 | 571.2 | 1627.0 | 244.9 |
| Total Manganese (Mn) | | | 0.20 | | |
| Total Iron (Fe) | 2.10 | 1.75 | 2.16 | 1.6 | 22.73 |
| Dissolved Iron | 0.10 | 0.05 | 0.04 | | 0.80 |
| Precipitated Iron | 2.00 | 1.70 | 2.12 | | 21.93 |
| Sulfate ($SO_4$) | 204.7 | 526.9 | 1331.7 | 1739.4 | 166.0 |
| Chloride (Cl) | 10.8 | 1803.8 | 24.5 | 1193.0 | 43.8 |
| Nitrate ($NO_3$) | 3.63 | 2.03 | 1.8 | 0.10 | 6.92 |
| Fluoride (F) | 0.3 | 2.6 | 0.8 | 2.2 | |
| Total Suspended Matter | 10.0 | 21.0 | 0. | 0. | 524.6 |
| Total Dissolved Solids | 686.0 | 4390.0 | 2232. | 5050.0 | 880.0 |
| Total Hardness | 413.0 | 204.8 | 771.7 | 370.0 | 148.3 |
| Carbonate Hardness | 327.0 | 204.8 | 250.5 | 370.0 | 148.3 |
| Non-carbonate Hardness | 86.0 | | 521.2 | 0.0 | |
| Percent of Alkalies | 29 | 95 | 62 | 91 | 79 |

* $Al_2O_3$ only

| CONSTITUENTS | IN PARTS PER MILLION | | | | |
|---|---|---|---|---|---|
| | F | G | H | I | J |
| Turbidity | 2 | 1 | turbid | turbid | turbid |
| Odor | none | none | | | |
| pH | 8.2 | 7.4 | | | |
| Alkalinity ($CaCO_3$) | 700.5 | 387.5 | 428.9 | 434.7 | 212.1 |
| Phenolpthalein | 46.0 | 0.0 | | | |
| Methyl Orange | 654.5 | 387.5 | | | |
| Carbonate ($CO_3$) | 27.6 | 0.0 | 1.4 | 00 | 00 |
| Bicarbonate ($HCO_3$) | 798.5 | 472.8 | 521.6 | 530.1 | 258.7 |
| Silica ($SiO_2$) | 5.0 | 9.8 | 10.0 | 11.2 | 7.6 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 1.0 | 1.0 | 2.80[a] | 1.60[a] | 1.20[a] |
| Calcium (Ca) | 10.5 | 111.8 | 26.8 | 70.3 | 244.3 |
| Magnesium (Mg) | 5.7 | 35.4 | 16.0 | 32.3 | 102.1 |
| Sodium(Na)and Potassium(k)as Na | 1016.6 | 85.0 | 1351.3 | 1758.5 | 1624.7 |
| Total Manganese (Mn) | 0.00 | 0.00 | | | |
| Total Iron (Fe) | 1.72 | 0.17 | | | |
| Dissolved Iron | 0.04 | 0.02 | | | |
| Precipitated Iron | 1.68 | 0.15 | | | |
| Sulfate ($SO_4$) | 488.9 | 132.9 | 752.2 | 1051.8 | 1023.3 |
| Chloride (Cl) | 582.5 | 9.8 | 1185.3 | 1676.1 | 2166.8 |
| Nitrate ($NO_3$) | 0.1 | 4.3 | | | |
| Fluoride (F) | 1.4 | 0.4 | | | |
| Total Suspended Matter | 2. | 23. | | | |
| Total Dissolved Solids | 2511. | 633. | 3567.0 | 4870.0 | 5609.0 |
| Total Hardness | 49.7 | 424.9 | 132.6 | 308.2 | 1029.3 |
| Carbonate Hardness | 700.5 | 387.5 | 132.6 | 308.2 | 212.1 |
| Non-carbonate Hardness | 0.0 | 37.4 | | | 817.2 |
| Percent of Alkalies | 98 | 30 | 96 | 92 | 77 |

[a] $Al_2O_3$ and $Fe_2O_3$

| CONSTITUENTS | IN PARTS PER MILLION | | | | |
|---|---|---|---|---|---|
| | K | L | M | N | O |
| Turbidity | turbid | turbid | turbid | turbid | turbid |
| Odor | | | | | |
| pH | | | | | |
| Alkalinity ($CaCO_3$) | 182.1 | 184.5 | 171.8 | 201.8 | 184.5 |
| Phenolpthalein | | | | | |
| Methyl Orange | | | | | |
| Carbonate ($CO_3$) | 00 | 00 | 00 | 00 | 00 |
| Bicarbonate ($HCO_3$) | 222.1 | 225.0 | 209.5 | 246.1 | 225.0 |
| Silica ($SiO_2$) | 1.6 | 8.4 | 21.6 | 21.6 | 2.0 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 1.60[a] | 0.80[a] | 1.2[a] | 2.40[a] | 1.60[a] |
| Calcium (Ca) | 111.7 | 163.1 | 176.9 | 134.9 | 182.0 |
| Magnesium (Mg) | 61.9 | 189.7 | 183.3 | 214.3 | 189.2 |
| Sodium(Na)and Potassium(k)as Na | 1506.7 | 1662.1 | 1687.7 | 1675.9 | 1735.7 |
| Total Manganese (Mn) | | | | | |
| Total Iron (Fe) | | | | | |
| Dissolved Iron | | | | | |
| Precipitated Iron | | | | | |
| Sulfate ($SO_4$) | 898.1 | 1060.6 | 1073.8 | 1064.1 | 1124.4 |
| Chloride (Cl) | 1898.3 | 2389.1 | 2352.0 | 2426.1 | 2490.9 |
| Nitrate ($NO_3$) | | | | | |
| Fluoride (F) | | | | | |
| Total Suspended Matter | | | | | |
| Total Dissolved Solids | 4737.0 | 6025.0 | 5996.0 | 6059.0 | 6363.0 |
| Total Hardness | 533.0 | 1185.5 | 1193.8 | 1215.9 | 1230.7 |
| Carbonate Hardness | 182.1 | 184.5 | 171.8 | 201.8 | 184.5 |
| Non-carbonate Hardness | 350.9 | 1001.0 | 1022.0 | 1014.1 | 1046.2 |
| Percent of Alkalies | 86 | 75 | 76 | 73 | 75 |

[a] $Al_2O_3$ and $Fe_2O_3$

| CONSTITUENTS | IN PARTS PER MILLION | |
|---|---|---|
| | P | Q |
| Turbidity | turbid | turbid |
| Odor | | |
| pH | | |
| Alkalinity ($CaCO_3$) | 179.8 | 219.0 |
| Phenolpthalein | | |
| Methyl Orange | | |
| Carbonate ($CO_3$) | 00 | 00 |
| Bicarbonate ($HCO_3$) | 219.3 | 267.1 |
| Silica ($SiO_2$) | 9.6 | 8.0 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 3.60[a] | 2.00[a] |
| Calcium (Ca) | 213.9 | 200.8 |
| Magnesium (Mg) | 174.5 | 177.8 |
| Sodium(Na)and Potassium(k)as Na | 1740.4 | 1656.2 |
| Total Manganese (Mn) | | |
| Total Iron (Fe) | | |
| Dissolved Iron | | |
| Precipitated Iron | | |
| Sulfate ($SO_4$) | 1153.8 | 1112.9 |
| Chloride (Cl) | 2463.2 | 2379.8 |
| Nitrate (NO3) | | |
| Fluoride (F) | | |
| Total Suspended Matter | | |
| Total Dissolved Solids | 6364.0 | 6004.0 |
| Total Hardness | 1250.2 | 1231.0 |
| Carbonate Hardness | 179.8 | 219.0 |
| Non-carbonate Hardness | 1070.4 | 1012.0 |
| Percent of Alkalies | 75 | 74 |

[a] $Al_2O_3$ and $Fe_2O_3$

A. Owner: CCC Camp near Eagleville, SE 1/4 SW 1/4 sec. 7, T. 66 N., R. 27 W. Total depth 750 feet. The well penetrated 108 feet of glacial drift and is bottomed in the Pennsylvanian System, yield 10 gallons per minute. Water sample from glacial drift at a depth of 103 feet. Analyzed April 11, 1935, by R. T. Rolufs.

B. As "A". Sampled at total depth of 750 feet, Pennsylvanian System. Analyzed April 11, 1935, by R. T. Rolufs.

C. Owner: Lincoln Folmer. NE 1/4 NW 1/4 SW 1/4 sec. 27, T. 66 N., R. 26 W. Well drilled September 24, 1955 to a total depth of 170 feet. 37 feet of 6 1/4 inch casing and 136 feet of 5 1/2 inch casing, the lower 20 feet being perforated. Yield 20 gallons per minute. Water from the Pleasanton formation of the Pennsylvanian System. Sampled June 28, 1956. Temperature of water 58°. Analyst: M. E. Phillips.

D. Owner: Town of Ridgeway. NW 1/4 NW 1/4 sec. 3, T. 64 N., R. 27 W. Total depth of 1178 feet. Well completed June, 1926. Water from the Pennsylvanian and Mississippian Systems. Sampled July 26, 1955. Analyzed by the Missouri Division of Health.

E. Owner: New Hampton Coal and Mining Company; Johnson Bros. NE 1/4 SW 1/4 sec. 17, T. 63 N., R. 29 W. Drilled to a total depth of 778 feet in 1913. Water from the lower Pennsylvanian System. Analyzed January 10, 1933 by R. T. Rolufs.

F. Owner: Marvin Rogers. SE 1/4 SW 1/4 SE 1/4 sec. 5, T. 63 N., R. 28 W. Total depth 165 feet. Sampled June 28, 1956. Analyst: M. E. Phillips.

G. Owner: Eddie Hurst. SW 1/4 NE 1/4 NE 1/4 sec. 19, T. 62 N., R. 27 W. Total depth 175 feet. Sampled June 28, 1956. Temperature of the water 54° F. Analyst: M. E. Phillips.

H. Owner: H. V. Elwell, et al, Number 1 John Maple. SW 1/4 SE 1/4 sec. 3, T. 62 N., R. 26 W. Completed September, 1939 at a total depth of 1907 feet. The test was bottomed in the Jefferson City formation of the Ordovician System. Sampled from the Cherokee formation of the Pennsylvanian System from the depth interval 467 to 482 feet. Analyzed October 4, 1939 by R. T. Rolufs.

I. As "H". Sampled from the Lower Cherokee formation of the Pennsylvanian System from the depth interval 600 to 650 feet. Analyzed October 4, 1939 by R. T. Rolufs.

J. As "H". Sample from Ste. Genevieve formation, Mississippian System from the depth interval 750 to 775 feet. Analyzed October 4, 1939 by R. T. Rolufs.

K. As "H". Sampled from the Devonian System at 1181 feet. Analyzed October 4, 1939 by R. T. Rolufs.

L. As "H". Sampled from the Devonian System from the depth interval 1369 to 1371 feet. Analyzed October 4, 1939 by R. T. Rolufs.

M. As "H". Sampled from basal sand zone of the Devonian System from the depth interval 1510 to 1513 feet. Analyzed October 4, 1939 by R. T. Rolufs.

N. As "H". Sampled from the Kimmswick formation; Ordovician System from the depth interval 1539 to 1544 feet. Static water level 200 feet. Collected September 24, 1939. Analyst: R. T. Rolufs.

O. As "H". Sample from the Decorah formation; Ordovician System from the depth interval 1695 to 1700 feet. Analyzed October 17, 1939 by R. T. Rolufs.

P. As "H". Sample from the St. Peter formation; Ordovician System from the depth interval 1765 to 1770 feet. Analyzed October 17, 1939 by R. T. Rolufs.

Q. As "H". Sample from the Cotter formation; Ordovician System from the interval 1903 to 1907 feet. Sampled October 2, 1939. Analyst: R. T. Rolufs.

Referring to Plate 1, it will be noted that a large area of Harrison County is unfavorably located to obtain water from glacial drift. Wells drilled into the consolidated rock to moderate depths may possibly obtain limited yields of water of marginal quality. The water from "rock" wells in all probabilities will become more mineralized with increased depth of drilling.

## QUALITY AND QUANTITY OF WATER FROM STREAMS

The streams of Harrison County are intermittent in their flow. Though the quality of the water is usually satisfactory, the undependable flow makes them unsuitable for irrigation or for municipal use.

One water analyses is available. The sample was collected from Big Creek down stream from Bethany, sec. 20, T. 63 N., R. 28 W. At the time the sample was collected, November 22, 1955, a large percent of the flow had

as its source the sewerage plant of Bethany. The temperature of the water was 44° F., of the air 59° F. The analyst was M. E. Phillips.

| CONSTITUENTS | IN PARTS PER MILLION |
|---|---|
| Turbidity | 30 |
| Odor | highly disagreeable, sweetish |
| pH | 8.1 |
| Alkalinity ($CaCO_3$) | 335.5 |
| Phenolpthalein | 0.0 |
| Methyl Orange | 335.5 |
| Carbonate ($CO_3$) | 0.0 |
| Bicarbonate ($HCO_3$) | 409.3 |
| Silica ($SiO_2$) | 6.7 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 8.7 |
| Calcium (Ca) | 86.5 |
| Magnesium (Mg) | 15.7 |
| Sodium (Na) and Potassium (K) as Na | 69.8 |
| Total Manganese (Mn) | 5.39 |
| Total Iron (Fe) | 2.31 |
| Dissolved Iron | 0.62 |
| Precipitated Iron | 1.69 |
| Sulfate ($SO_4$) | 69.5 |
| Chloride (Cl) | 60.3 |
| Nitrate ($NO_3$) | 0.0 |
| Fluoride (F) | 0.6 |
| Total Suspended Matter | 28. |
| Total Dissolved Solids | 512. |
| Total Hardness | 280.6 |
| Carbonate Hardness | 335.5 |
| Non-carbonate Hardness | |
| Percent of Alkalies | 35 |

The following are stream flow data from: Bolon, Harry C., Surface Waters of Missouri; Missouri Geological Survey and Water Resources, 2d ser., vol. 34, p. 324, 1952.

East Fork Big Creek near Bethany, Harrison County

Location. - Water-stage recorder and concrete control, lat. 40° 17' 50", long. 94° 01' 55", in SE 1/4 sec. 34, T. 64 N., R. 28 W., at bridge on U. S. Highway 69, 2 miles north of Bethany and 4 miles upstream from confluence with West Fork. Datum of gage is 854.74 feet above mean sea level, datum of 1929.

Drainage area. - 95 square miles.

Records Available. - March 1934 to September 1949.

Average Discharge. - 15 years, 50.3 second-feet.

Extremes. - 1934-49: Maximum discharge, 8,120 second-feet* June 6, 1947 (gage height, 17.65 feet) from rating curve extended above 2,600 second-feet; no flow on many days. Maximum stage known, 23.8 feet July 6, 1909.

Remarks. - Records good to fair except for periods of ice effect, which are poor.

Cooperation. - Station maintained by Surface Water Branch of the U.S.G.S. in cooperation with U. S. Soil Conservation Service and Corps of Engineers. Results of one discharge measurement furnished by U. S. Soil Conservation Service.

* one second-foot equals 448.83 gallons per minute.

## QUALITY OF WATER FROM GLACIAL DRIFT

In general, the water from the glacial drift is high in total iron, total dissolved solids, and sulfates. The iron content in the water may cause staining of plumbing fixtures and laundry; however, relatively inexpensive water treatment for the iron will prevent this staining. For most types of irrigation, total dissolved solids should not exceed 2000 parts per million and total alkalies should not exceed 75 percent. Most people cannot tolerate water for drinking purposes which contains more than 1500 parts per million of chloride, or 2000 parts per million sulfate. Water with 300 parts per million

of chloride tastes salty to some people. Sulfates in excess of 500 parts per million may have a laxative effect when first used for drinking.

The following are analyses from nine glacial drift wells.

| CONSTITUENTS | IN PARTS PER MILLION | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Turbidity | turbid | 10 | 140 | 95 | 25 |
| Odor | none | none | none | none | none |
| pH | 7.5 | 7.4 | 7.0 | 7.2 | 7.3 |
| Alkalinity ($CaCO_3$) | 180.5 | 615.5 | 302.5 | 289.0 | 191.5 |
| Phenolpthalein | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Methyl Orange | 180.5 | 615.5 | 302.5 | 289.0 | 191.5 |
| Carbonate ($CO_3$) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bicarbonate ($HCO_3$) | 220.2 | 750.9 | 369.1 | 355.6 | 233.6 |
| Silica ($SiO_2$) | 12.0 | 11.0 | 20.7 | 7.0 | 9.0 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 1.7 | 0.7 | 0.7 | 0.5 | 2.0 |
| Calcium (Ca) | 117.5 | 165.7 | 188.7 | 114.2 | 262.5 |
| Magnesium (Mg) | 32.1 | 61.7 | 37.7 | 37.8 | 75.2 |
| Sodium(Na)and Potassium(K) as Na | 537.4 | 257.3 | 188.8 | 451.6 | 626.3 |
| Total Manganese (Mn) | 0.00 | 0.00 | 0.41 | 0.00 | 0.00 |
| Total Iron (Fe) | 0.30 | 1.72 | 21.24 | 14.40 | 3.44 |
| Dissolved Iron | 0.14 | 0.10 | 0.06 | 0.08 | 0.05 |
| Precipitated Iron | 0.16 | 1.62 | 21.18 | 14.32 | 3.39 |
| Sulfate ($SO_4$) | 1101.7 | 356.0 | 463.0 | 795.5 | 1648.6 |
| Chloride (Cl) | 53.0 | 10.0 | 10.5 | 58.2 | 30.4 |
| Nitrate ($NO_3$) | 1.5 | 0.3 | 0.07 | 0.2 | 1.3 |
| Fluoride (F) | 0.9 | 0.2 | 0.3 | 0.8 | 0.8 |
| Total Suspended Matter | | 11. | 50. | 63. | 11. |
| Total Dissolved Solids | 1946. | 1168. | 1088. | 1610. | 2795. |
| Total Hardness | 425.5 | 667.7 | 626.4 | 440.6 | 965.0 |
| Carbonate Hardness | 180.5 | 615.5 | 302.5 | 289.0 | 191.5 |
| Non-carbonate Hardness | 245.0 | 52.2 | 323.9 | 151.6 | 773.5 |
| Percent of Alkalies | 71 | 46 | 39 | 69 | 59 |

| CONSTITUENTS | IN PARTS PER MILLION | | | |
|---|---|---|---|---|
| | 6 | 7 | 8 | 9 |
| Turbidity | 10 | 25 | turbid | clear |
| Odor | none | none | none | none |
| pH | 7.5 | 7.2 | 8.0 | 7.5 |
| Alkalinity ($CaCO_3$) | 487.5 | 388.5 | 185.0 | 354.5 |
| Phenolpthalein | 0.0 | 0.0 | 20.0 | 0.0 |
| Methyl Orange | 487.5 | 388.5 | 165.0 | 354.5 |
| Carbonate ($CO_3$) | 0.0 | 0.0 | 12.0 | 0.0 |
| Bicarbonate ($HCO_3$) | 594.8 | 474.0 | 201.3 | 432.5 |
| Silica ($SiO_2$) | 10.0 | 16.2 | 51.6 | 13.8 |
| Oxides ($Al_2O_3$, $Fe_2O_3$, $TiO_2$, etc.) | 1.0 | 0.6 | 27.3 | 0.2 |
| Calcium (Ca) | 137.6 | 89.0 | 55.8 | 80.6 |
| Magnesium (Mg) | 45.0 | 23.5 | 18.7 | 21.5 |
| Sodium(Na)and Potassium(K) as Na | 182.5 | 67.7 | 197.1 | 77.4 |
| Total Manganese (Mn) | 0.00 | 0.20 | 0.00 | 0.28 |
| Total Iron (Fe) | 1.28 | 2.92 | 0.51 | 0.90 |
| Dissolved Iron | 0.06 | 0.10 | 0.11 | 0.05 |
| Precipitated Iron | 1.22 | 2.82 | 0.40 | 0.85 |
| Sulfate ($SO_4$) | 276.1 | 26.9 | 242.0 | 52.3 |
| Chloride (Cl) | 8.0 | 3.5 | 117.5 | 9.3 |
| Nitrate ($NO_3$) | 4.6 | 0.8 | 2.5 | 0.3 |
| Fluoride (F) | 0.3 | 0.4 | 0.5 | 0.3 |
| Total Suspended Matter | 6. | 26. | | 2. |
| Total Dissolved Solids | 952. | 456. | 742. | 478. |
| Total Hardness | 528.8 | 319.7 | 216.3 | 289.8 |
| Carbonate Hardness | 487.5 | 388.5 | 185.0 | 354.5 |
| Non-carbonate Hardness | 41.3 | none | 31.3 | none |
| Percent of Alkalies | 43 | 32 | 67 | 37 |

1. Owner: Missouri Geological Survey test well number 252, NE 1/4 NE 1/4 NE 1/4 sec. 9, T. 65 N., R. 29 W. Total depth 219 feet. The well flowed. Temperature of water 55° F, of the air 90° F. Sampled June 25, 1956. Analyst: M. E. Phillips.

2. Owner: Carl Shain, NE 1/4 SW 1/4 SE 1/4 sec. 12, T. 65 N., R. 27 W. Total depth 135 feet, static water level 65 feet. Temperature 58° F, of air 83° F. Sampled June 28, 1956. Analyst: M. E. Phillips.

3. Owner: Methodist Church, Cainsville, Missouri, SE 1/4 SE 1/4 SW 1/4 sec. 12, T. 65 N., R. 26 W. Total depth 110 feet. Sampled June 28, 1956. Analyst: M. E. Phillips

4. Owner: Martinsville School, NE 1/4 NE 1/4 NE 1/4 sec. 21, T. 64 N., R. 29 W. Total depth 282 feet. Temperature 55° F., of air 77° F. Sampled June 28, 1956. Analyst: M. E. Phillips.

5. Owner: Mount Moriah School, SW 1/4 SW 1/4 NW 1/4 sec. 23, T. 64 N., R. 26 W. Sampled July 2, 1956. Analyst: M. E. Phillips.

6. Owner: Wm. T. Stevenson, SE 1/4 NW 1/4 NE 1/4 sec. 18, T. 63 N., R. 29 W. Total depth 100 feet. Sampled June 29, 1956. Analyst: M.E. Phillips.

7. Owner: Ira Hendron, NW 1/4 NW 1/4 NE 1/4 sec. 6, T. 63 N., R. 27 W. Total depth 42 feet, static water level 30 feet. Temperature of water 53° F, of air 77° F. Sampled June 28, 1956. Analyst: M. E. Phillips.

8. Owner: Missouri Geological Survey test well number 202, sec. 8, T. 62 N., R. 29 W. Total depth 329 feet. Temperature 65° F., of air 62° F. Sampled May 15, 1956. Analyst: M. E. Phillips.

9. Owner: Jewel Maize, SE 1/4 SE 1/4 SE 1/4 sec. 25, T. 62 N., R. 29 W. Total depth 72 feet, static water level 25 feet. Temperature of the water 53° F., of the air 86° F. Sampled June 28, 1956. Analyst: M. E. Phillips.

## QUANTITY OF WATER FROM GLACIAL DRIFT

DOMESTIC WELLS - Included in this category are wells developed for household or general farm use. Yields required from domestic wells vary but seldom exceed 15 gallons per minute. In some parts of Harrison County sands and gravels were not deposited in the glacial drift. There are also areas where the glacial drift cover is relatively thin or lacking. In such areas the possibility of developing wells is limited. Plate 1 shows the area most favorable for the development of domestic wells. Plate 3 is a contour map showing the elevation of bedrock above sea level. To determine probably drilling depths, the elevation of the bedrock should be subtracted from the

surface elevation for each specific site. Plate 3 also shows the locations of the test holes and the thickness of the glacial drift encountered.

IRRIGATION WELLS - Included in this category are all high yield wells whether used by cities, by industries, or for irrigation. Plate 2 shows the area most favorable for the development of irrigation wells. Also shown are the locations of seventeen wells which flowed and the location of the well for which sieve analyses were made of the sands. The results of the sieve analyses are shown on Plate 4.

With proper development, yields of 200-1000 gallons per minute may be obtained. This is an estimate and is not based upon actual pumping tests within the area. Yields to be expected are contingent upon several factors:

(1) The thickness of the sand and gravel beds.
(2) The size and sorting of the sand and gravel.
(3) The manner of construction and materials used, such as proper well screen, gravel pack, etc.
(4) Ability of the well driller to develop the full capacity of the water bearing sands.

Continued successful production is contingent upon:

(1) Re-charge rate of the water-bearing horizons.
(2) Quality of the screen and materials used.
(3) Subsequent well treatment such as acidizing.
(4) Avoidance of over-pumpage.


Base by the Missouri State Highway Department, 1949

LEGEND

Area most favorable

$O^4$ Location of wells in drift from which water was analyzed

$\square^H$ Water sample analyzed from a "rock" well

X Water sample analyzed from a stream

N

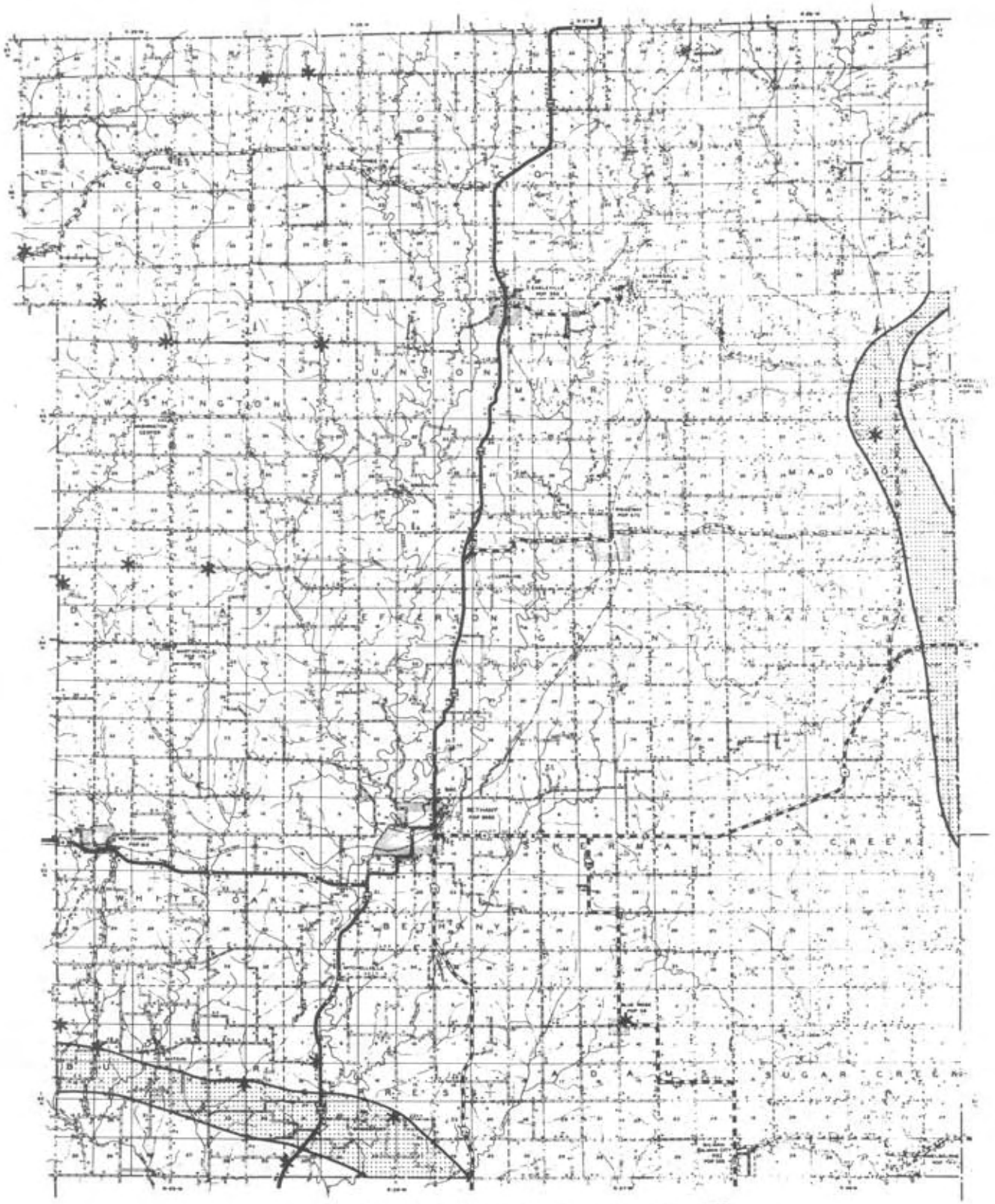
PLATE 1

MAP OF HARRISON COUNTY
SHOWING
AREA MOST FAVORABLE FOR THE DEVELOPMENT OF WELLS IN DRIFT

BY
DALE L. FULLER
J. R. McMILLEN
W. B. RUSSELL
1956

MISSOURI GEOLOGICAL SURVEY
AND WATER RESOURCES
ROLLA, MISSOURI

THOMAS R. BEVERIDGE
STATE GEOLOGIST




*Base by the Missouri State Highway Department, 1949*

LEGEND

*Drift filled valley*

* *Test wells that flowed*

* *Sand analyses from this well shown on plate 4*

N

PLATE 2

MAP OF HARRISON COUNTY
SHOWING
DRIFT FILLED VALLEYS IN WHICH IRRIGATION WELLS POSSIBLY CAN BE DEVELOPED

BY
DALE L. FULLER
J. R. McMILLEN
W. B. RUSSELL
1956
MISSOURI GEOLOGICAL SURVEY
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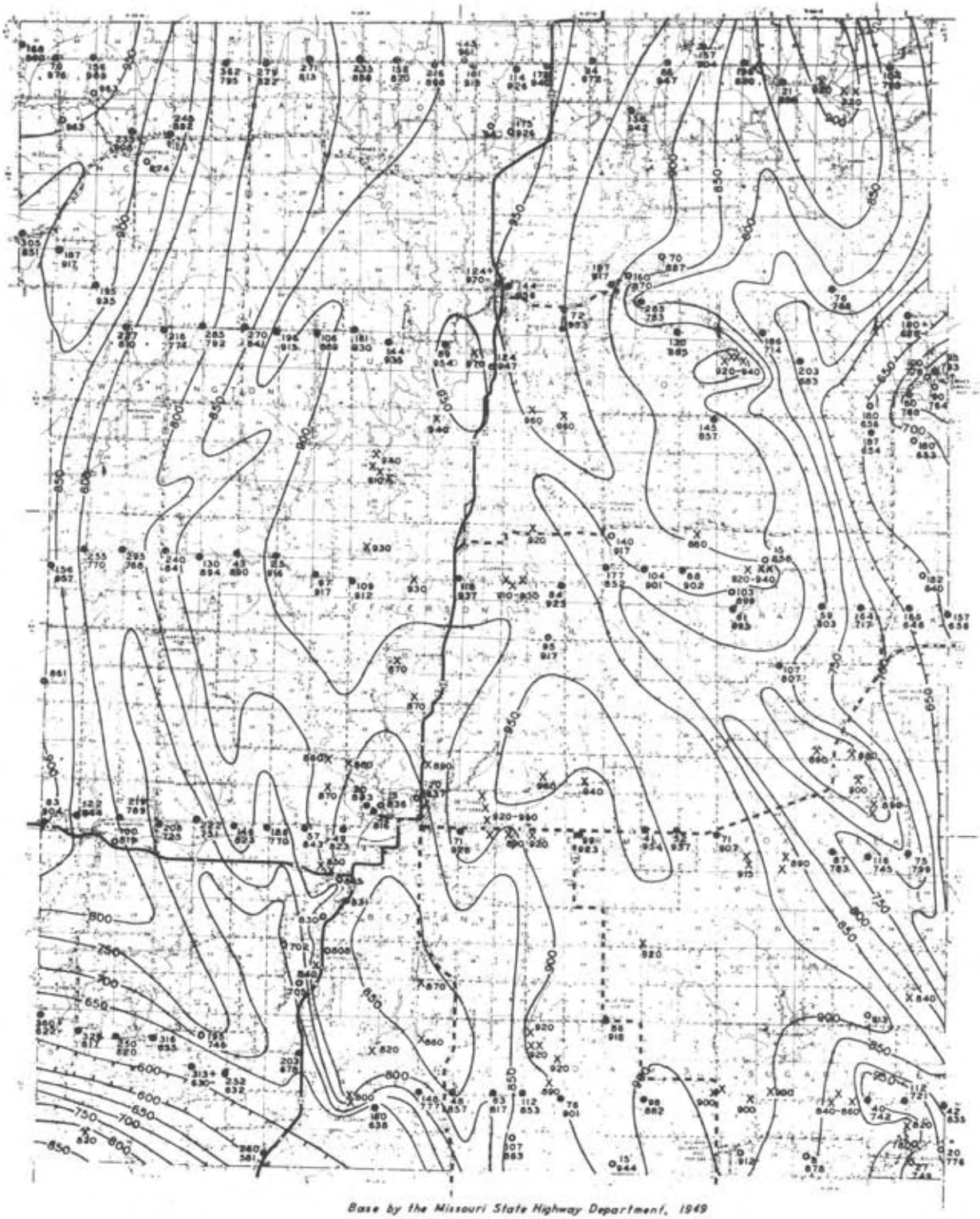
ROLLA, MISSOURI
THOMAS R. BEVERIDGE
STATE GEOLOGIST



*Base by the Missouri State Highway Department, 1949*

LEGEND

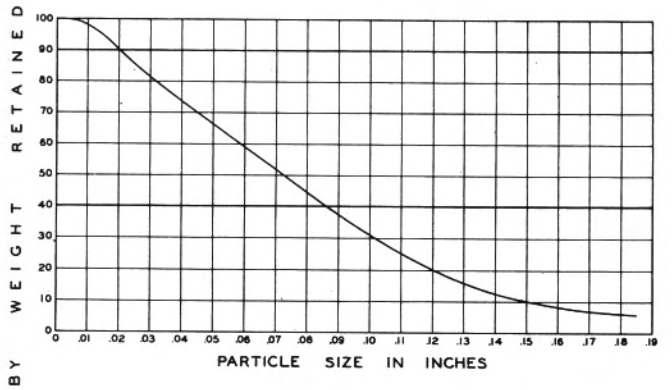
- 135 / 850 — *Test holes showing thickness in feet of drift and elevation of bedrock above sea level.*
- o — *Water wells*
- X — *Bedrock Outcrops*
- X — *Mine or Quarry*
- 920-960 — *Indicates range of outcrop elevation*
- *Indicates channel*
- *Contour interval 50 feet*

-N-

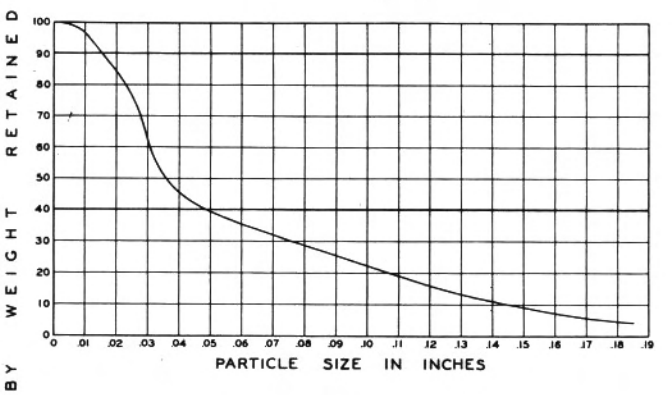
CONTOUR MAP
OF
HARRISON COUNTY
SHOWING
BEDROCK ELEVATIONS
BY
DALE L. FULLER
J. R. McMILLEN
W. B. RUSSELL
1956
MISSOURI GEOLOGICAL SURVEY
AND WATER RESOURCES
ROLLA, MISSOURI
THOMAS R. BEVERIDGE
STATE GEOLOGIST

PLATE 3

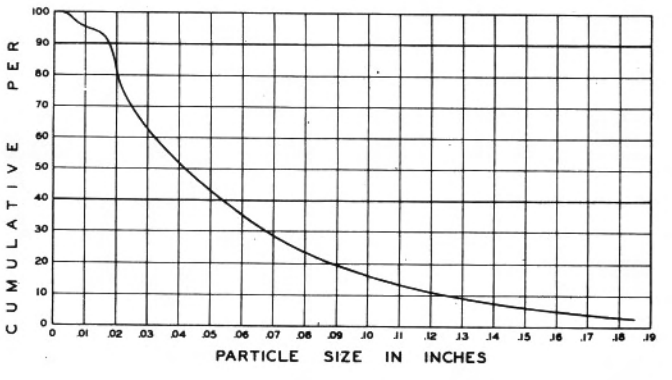
195 - 240 SANDS



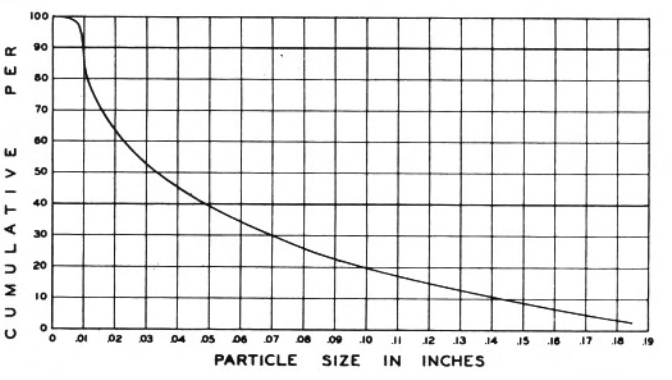

240 - 250 SANDS




250 - 265 SANDS




265 - 279 SANDS




# SIEVE ANALYSES OF SANDS

## FOUND AT VARIOUS DEPTHS IN

## TEST WELL Nº 285

NE ¼ NE ¼ NW ¼ SEC. 6, T. 66 N., R. 28 W., HARRISON CO., MISSOURI

DALE FULLER, AUGUST, 1956

MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES
THOMAS R. BEVERIDGE, STATE GEOLOGIST

PLATE 4

## SUMMARY

Approximately 17,000 acres of Harrison County are located within the area in which irrigation wells possibly can be developed. Nearly two-thirds of Harrison County's area is suitably located for obtaining water sufficient for domestic needs from the glacial drift.

Questions concerning water problems for a specific location should be sent to the Missouri Geological Survey, Rolla, Missouri.